

# Variable Persistence/Storage

Models 1741A, 1744A

- 200 cm/ $\mu$ s variable persistence & stored writing speed
- Minimum blind time, auto-intensity

- Dual channel, 5 mV/div to 100 MHz
- 3rd channel trigger view and selectable input impedance

1741A Opt 034



## 1741A, 1744A Variable Persistence/Storage

Hewlett-Packard Variable Persistence/Storage Oscilloscopes provide a "one oscilloscope" solution to the wide variety of measurements encountered daily. The versatility results from the multitude of operating modes available; starting with minimum persistence, which approximates conventional operation, through continuous persistence settings, all the way to automatic storage. The adjustable persistence control provides the ability to match signal and persistence characteristics resulting in excellent display characteristics over a wide range of conditions.

### Applications

These oscilloscopes provide a clear display of virtually any signal; however, they are especially useful in certain applications. Low repetition rate signals at fast sweep speeds produce very low light output on conventional CRTs and normally require the use of a viewing hood to obtain a viewable display. The variable persistence mode solves this problem by integrating several sweeps to amplify the light output, thereby producing bright, clear traces. This "light-integrating" capability is also useful in eliminating flickering displays, which are the result of low repetition rates and slow sweep speed signals. These signals are annoying to view and even more difficult to measure; however, the display is improved by matching signal and persistence characteristics.

Single-shot events are also captured easily by using the auto-store mode, which, once set, will wait and capture a sweep after the first trigger event. During operation of the oscilloscope, any display on the CRT can be saved at the touch of a button, no matter what mode the instrument is in.

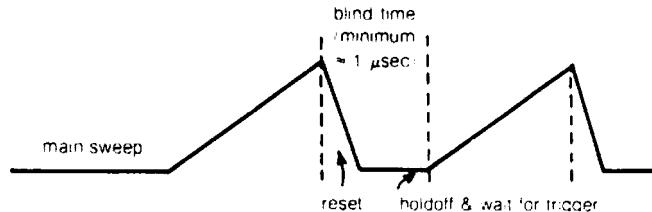
### Writing Speed and Blind Time

In all Hewlett-Packard storage oscilloscopes, the advanced technology allows signals to be captured at the maximum writing speed in both variable persistence and single-shot modes (1741A-200 cm/ $\mu$ s; 1744A-1800 cm/ $\mu$ s; 1727A-2000 cm/ $\mu$ s). These fast writing

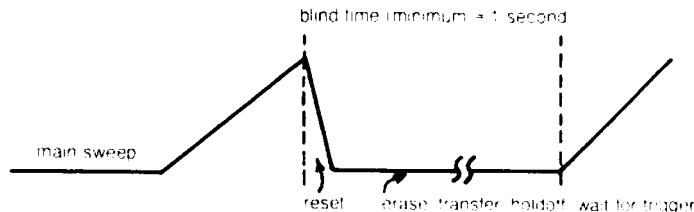
speeds are achieved without reduced scans or excessive blind times. Operating in the variable persistence mode, high speed signals can be scanned without transfer or erase time (typically 1 second) necessary in other storage techniques. The probability of displaying a random event is increased by decreasing the blind time by a factor of 1000 or more in most situations.

### A Comparison - Fast Writing Modes

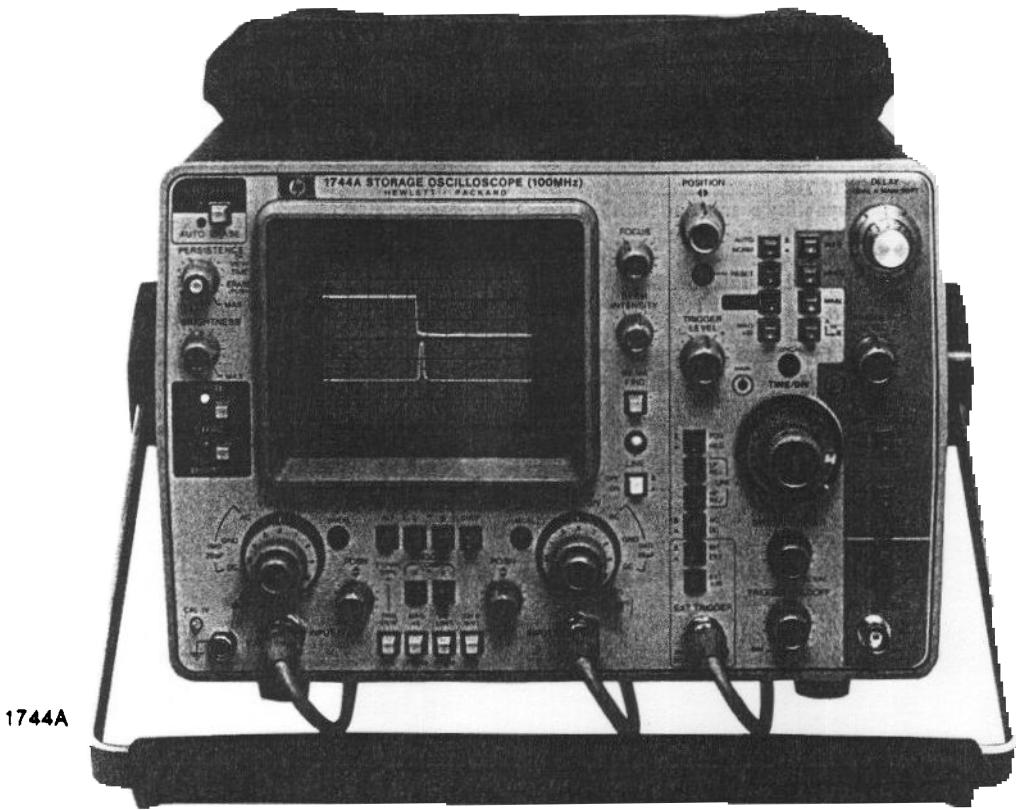
#### 1. HP's Variable Persistence Mode



#### 2. Transfer Techniques Not Used in HP Variable Persistence/Storage Oscilloscopes



- 1800 cm/ $\mu$ s variable persistence & stored writing speed
- Minimum blind time, auto-intensity circuit
- Dual channel 5 mV/div to 100 MHz
- 3rd channel trigger view and selectable input impedance



#### 1741A, 1744A 1727A Operation

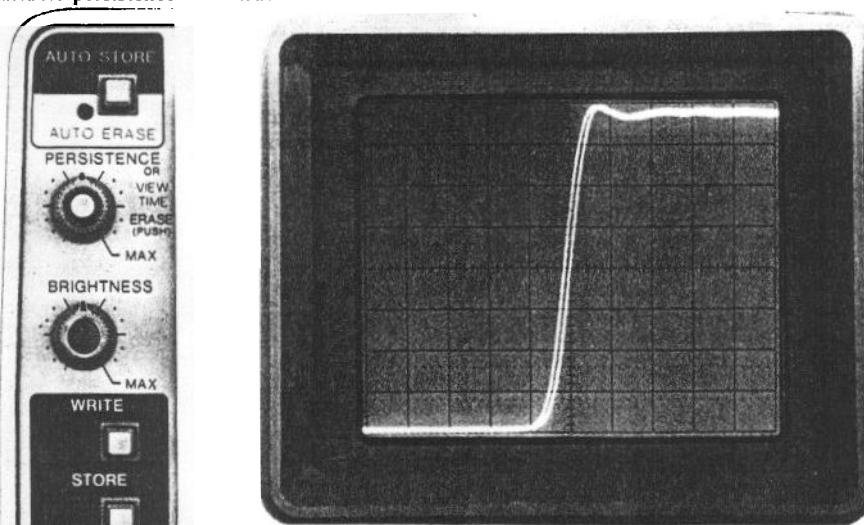
An auto-intensity circuit in all of these variable persistence/storage oscilloscopes simplifies operation. This circuit permits sharp, flicker-free, non-blooming traces to be obtained in the variable persistence mode under almost all operating conditions.

There is a variety of settings available in the variable persistence mode; however, there is an easily set reference position that will provide a viewable trace: Intensity—max, Persistence—min, Brightness—min. From this position, Intensity can be decreased and Persistence can be increased as necessary.

In addition to the variable persistence mode, storage LEDs provide positive identification of storage operating modes. The auto-erase mode periodically takes individual "snapshots" of an input signal. In this mode, Persistence is internally set to maximum and the persistence control regulates how frequently a new "snapshot" is captured and displayed when two or more channels are displayed. The required number of sweeps are captured before a new cycle is initialized. This mode offers "hands-off" operation for probing circuits and a convenient method of quickly setting the focus and intensity for single-shot events.

The auto-store mode makes single-shot events easy to capture and reduces the possibility of recording the wrong event by automatically switching to the normal trigger mode. The oscilloscope automatically switches from a "write" mode to a

"store" mode after the sweep of the single-shot event for maximum trace retention time. A "store" LED indicates that the event is captured and one press of the Store/Display button displays the stored trace.



Exceptionally fine trace in the variable persistence mode permits high resolution timing measurements as shown with this dual trace, alternate sweep display at a sweep speed of 5 ns/div.





## 1740A, 1741A, 1742A, 1743A, 1744A

### Specifications

#### Vertical Display Modes

Channel A; channel B; A and B displayed alternately on successive sweeps (ALT); A and B displayed by switching between channels at  $\approx 250$  kHz rate with blanking during switching (CHOP); A plus B (Algebraic addition); and trigger view.

**Vertical amplifiers (2)** Bandwidth and Rise Time at all deflection factors from 0°C to +55°C.

**Bandwidth:** 3 dB down from 8 div reference signal; 3 dB down from 6 div reference signal for 1741A, 1744A.

**DC-coupled:** dc to 100 MHz in both 50Ω and 1 MΩ input modes.

**AC-coupled:**  $\approx 10$  Hz to 100 MHz.

**Bandwidth limit:** limits upper bandwidth to  $\approx 20$  MHz.

**Rise time:**  $\leq 3.5$  ns measured from 10% to 90% points of a 6 div (5 div, 1744A) input step.

#### Deflection Factor

**Ranges:** 5 mV/div to 20 V/div (12 calibrated positions) in 1, 2, 5 sequence, attenuator accuracy  $\pm 3\%$ .

**Vernier:** extends deflection factor to  $\geq 50$  V/div.

**Polarity:** channel B may be inverted.

**Input coupling:** selectable AC or DC, 50Ω (dc), or ground.

**Input RC (selectable):** AC or DC, 1 MΩ  $\pm 2\%$  shunted by  $\approx 20$  pF; 50Ω, 50Ω  $\pm 3\%$ , SWR  $\leq 1.4$  at 100 MHz.

**Maximum input:** AC or DC, 250 V (dc + peak ac) or 500 V p-p at  $\leq 1$  kHz; 50Ω, 5 V rms.

#### A + B Operation

**Amplifier:** bandwidth and deflection factors are unchanged; channel B may be inverted for A-B operation.

**Differential (A-B) common mode:** CMR is at least 20 dB from dc to 20 MHz. Common mode signal amplitude equivalent to 8 div (6 div, 1744A) with one vernier adjusted for optimum rejection.

#### Vertical Magnification (X5)

**Bandwidth:** 3 dB down from 8 div (6 div, 1744A) reference signal.

**DC-coupled:** dc to  $\approx 40$  MHz; dc to  $\approx 30$  MHz for 1741A, 1744A.

**AC-coupled:**  $\approx 10$  Hz to 40 MHz;  $\approx 10$  Hz to 30 MHz for 1741A, 1744A.

**Rise time:**  $\leq 9$  ns,  $\leq 12$  ns for 1741A, 1744A (measured from 10% to 90% points of 8 div, 5 div 1744A, input step).

**Deflection factor:** increases sensitivity of 5 and 10 mV settings by a factor of 5 with max sensitivity of 1 mV on channels A and B.

#### Trigger Source

Selectable from channel A, channel B, composite, or line frequency.

#### Trigger View

Displays internal or external trigger signal. In Alternate or Chop mode, channel A, channel B, and the trigger signals are displayed. In channel A or B mode, trigger view overrides that channel. Internal trigger signal amplitude approximates vertical signal amplitude. Ext trigger signal deflection factor is 100 mV/div or 1 V/div in EXT  $\div 10$ . Triggering point is approx center screen. With identically timed signals to a vertical input and the EXT trigger input, trigger signal delay is  $\leq 3.5$  ns.

#### Horizontal Display Modes

Main,  $\Delta$ time with channel A or B start (1742A, 1743A), main intensified, mixed (except 1743A), delayed, mag X 10, and A vs. B.

#### Main and Delayed Time Bases

##### Ranges

**Main:** 50 ns/div to 2 s/div (24 ranges) in 1, 2, 5 sequence.

**Delayed:** 50 ns/div to 20 ms/div (18 ranges) in 1, 2, 5 sequence.

##### Accuracy

Sweep Time, Div	*Accuracy		Temp Range
	X1	X10	
50 ns to 20 ms	$\pm 3\%$	$\pm 4\%$	0°C to +15°C
	$\pm 2\%$	$\pm 3\%$	+15°C to +35°C
	$\pm 3\%$	$\pm 4\%$	+35°C to +55°C

\* Add 1% for 50 ms to 2 s ranges

**Main sweep vernier:** extends slowest sweep to at least 5 s/div.

**Magnifier (X10):** extends fastest sweep to 5 ns/div.

#### Calibrated Sweep Delay (except 1743A)

**Delay time range:** 0.5 to 10 X Main Time/Div settings of 100 ns to 2 s (min delay 150 ns).

## Models 1740A, 1741A, 1742A, 1743A & 1744A (cont.)

#### Differential Time Measurement Accuracy

(Using one intensified marker and helidial control)

Main Time Base Setting	Accuracy* (+15°C to +35°C)
100 ns/div to 20 ms/div	$\pm (0.5\% \text{ of reading} + 0.1\% \text{ of fs})$
50 ms/div to 2 s/div	$\pm (1\% \text{ of reading} + 0.1\% \text{ of fs})$

\*Add 1% for temperature from 0°C to +15°C and +35°C to +55°C.

**Delay jitter:**  $< 0.002\%$  (1 part in 50 000) of max delay in each step from +15°C to +35°C;  $< 0.005\%$  (1 part in 20 000) from 0°C to +15°C and +35°C to +50°C.

#### Differential Time Measurement Accuracy (1742A)

(Using  $\Delta$ time dual intensified markers)

Main Time Base Setting	Accuracy* (+15°C to +35°C)		
	Opt 034/035	External DVM***	Helidial
100 ns** to 20 ms/div	$\pm (0.5\% \text{ of reading} + 0.05\% \text{ of fs})$	$\pm (0.5\% \text{ of reading} + 0.05\% \text{ of fs})$	$\pm (0.5\% \text{ of reading} + 0.1\% \text{ of fs})$
50 ms to 2 s/div	$\pm (1\% \text{ of reading} + 0.1\% \text{ of fs})$	$\pm (1\% \text{ of reading} + 0.1\% \text{ of fs})$	$\pm (1\% \text{ of reading} + 0.1\% \text{ of fs})$

\*Add 1% for temperatures from 0°C to +15°C and +35°C to +55°C.

\*\*On 100 ns/div range, specification applies after first cm of main sweep.

\*\*\*Add DVM accuracy.

#### Time Interval ( $\Delta$ Time) 1742A

**Function:** measures time interval between two events on channel A (A display); two events on channel B (B display); or two events starting from an event on either channel A or B and ending with an event on either channel A or B (alternate display).

**Time interval output voltage:** varies from 50 V to 100 mV full scale. Full scale output voltage can be determined by multiplying the number on the Time/Div dial by 10 V (e.g. 0.05 s, 0.05 ms, or 0.05  $\mu$ s per div gives 0.5 V output full-scale).

**Stability (0°C to +55°C):** short-term 0.005%. Temperature,  $\pm 0.03\%/\text{°C}$  deviation from calibration temperature range.

#### Crystal Referenced $\Delta$ Time (1743A)

**Delay time range:** 0 to 10 X Main Time/Div settings of 100 ns to 2 s.

#### Differential time measurement accuracy

**Accuracy:**  $\pm 0.002\%$  of reading  $\pm 1$  count from +15°C to +35°C;  $\pm 0.005\%$  of reading  $\pm 1$  count from 0°C to +15°C and +35°C to +55°C.

#### Time Resolution of $\pm 1$ Count

Sweep Ranges/div	$\pm 1$ Count	Averages
0.1 s, 0.2 s, 0.5 s	$\pm 100$ ns	10 000
1 s, 2 s, 5 s	$\pm 1$ ns	1 000
10 s, 20 s, 50 s	$\pm 10$ ns	100
0.1 ms, 0.2 ms, 0.5 ms	$\pm 100$ ns	direct

**Readout:** 5 digit LED plus exponent.

**Crystal Aging:** 0.0005% per year.

**Delay jitter:** same as other 1740 series oscilloscopes.

#### Triggering

##### Main Sweep

**Normal:** sweep is triggered by internal or external signal.

**Automatic:** baseline displayed in absence of input signal. Above  $\approx 40$  Hz, triggering is same as normal.

**Single:** sweep occurs once with same triggering as Normal. Reset arms sweep and lights indicator. (1741A, 1744A) Single sweep is also initiated with Erase. sweep is armed after the erase cycle.

**Internal:** dc to 25 MHz on signals  $\geq 0.3$  div vertical deflection, increasing to 1 div vertical deflection at 100 MHz in all display modes (required signal level is increased by 2 when in Chop mode and by 5 when X5 vertical magnifier is used).

**External:** dc to 50 MHz on signals of 50 mV p-p or more, increasing to 100 mV p-p at 100 MHz (required signal level is increased by 2 when in Chop mode).

#### Delayed Sweep (Sweep After Delay)

**Auto:** delayed sweep starts at end of delay period.

**Trig:** delayed sweep armed and triggerable at end of delay period.

**Internal:** same as Main Sweep except 1743A is dc to 25 MHz on signals causing 1 div or more vertical deflection, increasing to 2 div of vertical deflection at 100 MHz.

**External:** same as Main sweep except 1743A is dc to 50 MHz on signals 100 mV p-p increasing to 200 mV p-p at 100 MHz.

# OSCILLOSCOPES



**External input RC:**  $\approx 1 \text{ M}\Omega$  shunted by  $\approx 20 \text{ pF}$ ; max external input, 250 V (dc + peak ac) or 500 V p-p at  $\leq 1 \text{ kHz}$ .

**Level and slope:** internal, at any point on positive or negative slope of displayed waveform; external, continuously variable from +1 V to -1 V on either slope of trigger signal, +10 V to -10 V in + 10.

**Coupling:** AC, DC, LF REJ, or HF REJ.

**Trigger holdoff (main sweep):** increases sweep holdoff, all ranges.

## Calibrated Mixed Time Base (except 1743A)

Dual time base in which the main time base drives the first portion of sweep and the delayed time base completes the sweep at the faster delayed sweep. Also operates in single sweep mode. Accuracy, add 2% to main time base accuracy.

## A vs B Operation (deleted with Opt 101)

**Bandwidth:** channel A (Y-axis), same as channel A; channel B (X-axis), dc to 5 MHz.

**Deflection factor:** 5 mV/div to 20 V/div (12 cal positions) in 1, 2, 5 sequence; phase difference between channels,  $<3^\circ$ , dc to 100 kHz (75 kHz, 1743A).

## Cathode-ray Tube and Controls (1740A, 1742A, 1743A)

**Type:** 12.7 cm (5 in.) rectangular CRT, post accelerator,  $\approx 15 \text{ kV}$  accelerating potential, aluminized P31 phosphor.

**Graticule:** 8 x 10 div (1 div = 1 cm) internal non-parallax graticule, 0.2 subdivision markings on major horizontal and vertical axes and markings for transition time measurements. Internal floodgun graticule illumination.

**Beam finder:** returns trace to CRT screen.

**Z-axis Input (Intensity modulation):** +4 V,  $\geq 50 \text{ ns}$  wide pulse blanks trace of any intensity, usable to  $\leq 10 \text{ MHz}$  for normal intensity. Input R,  $1 \text{ k}\Omega \pm 10\%$ . Max input  $\pm 20 \text{ V}$  (dc + peak ac).

**Rear panel controls:** astigmatism and trace align.

## Cathode-ray Tube and Controls (1741A)

**Type:** 12.7 cm (5 in.) rectangular CRT, post accelerator,  $\approx 7.5 \text{ kV}$  accelerating potential, aluminized P31 phosphor.

**Graticule:** 8 x 10 div (1 div = 0.85 cm) internal, non-parallax graticule, 0.2 subdivision markings on major horizontal and vertical axes, with markings for transition time measurements. Graticule illumination is achieved with Persistence control set to min.

**Beam finder:** returns trace to CRT screen.

**Z-axis Input (Intensity modulation):** same as 1740A.

**Operating modes:** write, store, display, auto-store, auto-erase, and conventional (rear panel control).

**Persistence:** variable,  $\approx 100 \text{ ms}$  to 1 min; conventional,  $\approx 40 \mu\text{s}$ .

**Writing speed, variable persistence and storage:**  $\geq 200 \text{ cm}/\mu\text{s}$  (235 div/ $\mu\text{s}$ ) over center 7 x 9 div (with viewing hood).

**Storage time:** display mode, at least 10 s at  $22^\circ\text{C}$ ; store mode, at least 30 s at  $22^\circ\text{C}$ .

**Brightness:**  $\approx 170 \text{ cd}/\text{m}^2$  (50 ft) increasing to  $\approx 340 \text{ cd}/\text{m}^2$  (100 ft) depending on brightness control setting.

**Erase time:**  $\approx 300 \text{ ms}$ .

**Rear panel controls:** astigmatism, trace align, conventional push-button, and view time.

## Cathode-ray Tube and Controls (1744A)

**Type:** 12.7 cm (5 in.) rectangular CRT, post accelerator,  $\approx 10 \text{ kV}$  accelerating potential, aluminized P31 phosphor.

**Graticule:** 8 x 10 div (1 div = 0.72 cm) internal graticule, 0.2 subdivision markings on major horizontal and vertical axes, with markings for transition time measurements. Graticule illumination is achieved with Persistence control set to min.

**Beam finder, Z-axis Input (Intensity modulation):** See 1740A.

**Operating modes:** write, store, display, auto-store, and auto-erase.

**Writing speed, variable persistence and storage:**  $\geq 1800 \text{ cm}/\mu\text{s}$  (2500 div/ $\mu\text{s}$ ) over center 6 x 8 div (with viewing hood).

**Storage time:** store mode, at least 30 s; view mode, at least 10 s; wait time, at least 60 s, at  $22^\circ\text{C}$ .

**Persistence:** variable (100 ms min).

**Erase time:**  $\approx 300 \text{ ms}$ .

**Rear panel controls:** astigmatism and trace align.

## General

**Rear Panel outputs:** main and delayed gates, 0.8 V to  $\geq +2.5 \text{ V}$  capable of supplying  $\approx 5 \text{ mA}$ .

## Amplitude Calibrator (0°C to +55°C)

Output voltage	1 V p-p into $\geq 1 \text{ M}\Omega$ 0.1 V p-p into 500	$\pm 1\%$
Rise time	$\approx 0.1 \mu\text{s}$	
Frequency	$\approx 1.4 \text{ kHz}$	

**Power:** 100, 120, 220, 240 V ac  $\pm 10\%$ ; 48 to 440 Hz; 100 VA max.

**Weight:** (1740, 1742) net, 13 kg (28.6 lb); shipping 15.7 kg (34.6 lb). (1741, 1743, 1744) net 13.8 kg (30.5 lb); shipping 17.7 kg (39 lb).

**Operating environment:** temperature  $0^\circ\text{C}$  to  $+55^\circ\text{C}$ ; humidity to 95% relative humidity at  $+40^\circ\text{C}$ ; altitude, to 4600 m (15 000 ft); vibration, vibrated in three planes for 15 min. each with 0.254 mm (0.010 in.) excursion, 10 to 55 Hz.

**Size:** (1740A) 197 H x 335 W x 597 mm D (7.8" x 13.2" x 23.5") with handle, 492 mm D (19.4") without; (1741A) 616 mm D (24.3") with handle, 552 mm D (21.7") without; (1742A) 570 mm D (22.4") with handle, 502 mm D (19.8") without; (1743A) 613 mm D (24.1") with handle, 549 mm D (21.6") without; (1744A) 635 mm D (25") with handle; 511 mm D (20.1") without.

**Accessories furnished:** one blue light filter HP P/N 01740-02701, one front panel cover, one 2.3 m (7.5 ft) power cord, one vinyl accessory storage pouch, one Operators Guide and one Service Manual, two Model 10041A 10:1 divider probes  $\approx 2 \text{ m}$  (6.6 ft) long. The 1741A and 1744A also include one Model 10173A RF1 filter and contrast screen, and one Model 10140A viewing hood.

## Options and Accessories

**001:** fixed power cord (U.S. only).

**002 (1741A):** Triggered A vs B Mode; phase shift  $\leq 2^\circ$ , dc to 5 MHz; internal triggering on channel B.

**003:** Auto Camera (1741A)

**005 (1740A or 1741A):** TV sync

**034 (except 1743A, 1744A):** built-in DMM (60 Hz)

**035 (except 1743A, 1744A):** built-in DMM (50 Hz)

**091:** two 3 m (9.8 ft) 10042A 10:1 probes in lieu of 10041A probes

**096:** two 1.8 m (6 ft) 10006D 10:1 probes in lieu of 10041A probes.

**101 (except 1744A):** state display (deletes A vs B mode) single switch interface for use with 1607A Logic State Analyzer.

**112:** includes 1112A Inverter Power Supply, a portable power source for 1700 series oscilloscopes.

**910:** extra set of product manuals.

**Multimeter kit:** HP P/N 01742-69501 (1742A), 01741-69502 (1741A), or 01740-69503 (1740A) adapts standard oscilloscope to an Option 034/035 with built-in LED readout. Kit includes a multimeter, top oscilloscope cover, vinyl storage pouch, and mounting hardware.

**Opt 101 Field Instl Kit:** converts std 1740 series oscilloscopes (except 1744A) to Opt 101. Order HP P/N 01740-69501 for 1740A, 1742A, 1743A; order HP P/N 01741-69501 for 1741A.

## Logic State Analysis Equipment Required for Option 101

**1607A:** 16-Bit Logic State Analyzer including three data probes and one clock probe.

**Four 10121A:** 20 cm (8") cables. Three for X, Y, and Z and one for pattern trigger connections.

**Adapter plate and strap:** (HP P/N 5061-1213) for mounting the oscilloscope on top of the 1607A.

## Ordering Information

**1740A 100 MHz Oscilloscope**

**1741A 100 MHz Storage Oscilloscope**

**1742A 100 MHz  $\Delta$ Time Oscilloscope**

**1743A 100 MHz  $\Delta$ Time Oscilloscope**

**1744A 100 MHz Storage Oscilloscope**